Remediation not always possible at Redstone Arsenal

by Verdelle Lambert

You can't remediate what you can't find, and when contaminants are dispersed in complex hydrogeological settings like karst, the task can be overwhelming.

That's the challenge facing Savannah District and its contractor, Shaw Environmental, Inc., at Operable Unit 10 (OU-10), the worst of 18 Operable Units EPA has identified for remediation at Redstone Arsenal.

The EPA Superfund site is a 38,000-acre facility near Huntsville, Alabama. It sits atop a thick sequence of carbonate rocks called karst, which, through weathering, have formed more than 13,000 sinkholes, 20 enterable caves, and 424 springs.

During World War II, the military manufactured conventional, chemical and incendiary munitions at Redstone. From 1949 to 1996 the Army developed rocket propellants (perchlorate) at OU-10, which is a 1,980-acre area within Redstone. Standard investigations conducted there from 1998 through 2001 indicated the presence of extensive perchlorate and trichloroethene (TCE) plumes and solvent-based DNAPLs[1] in the soil and water at levels that make the groundwater unacceptable for drinking water.

"The mission of the Installation Restoration Program at Redstone Arsenal is to ensure that the facility is available for military and civilian uses with regard to human and ecological health," said John Blandamer, Redstone Arsenal technical lead. "We will determine which areas are contaminated, whether they present a risk to human health or the environment and, if they do, clean them up to safe levels for their intended use."

Over the last two years, Shaw Environmental has conducted a holistic investigation to find out where the contaminants are, how they move from one place to another within the bedrock, and where they may move in the future. The results will help identify remedial alternatives and determine the lateral and vertical limits of remediation, according to Wes Smith, Savannah District's project geologist. It will take Shaw Environmental a year or so to fully interpret the data. Early results show that the DNAPLs have formed a complex set of commingled plumes at various depths and "compartments" within the karst groundwater flow system. There is evidence that the compartments are hydraulically interconnected in a very dynamic fashion, allowing contaminants to travel long distances in a very short time. Evidence of highly dynamic groundwater-surface water interaction also exists.

"These DNAPLs are really hard to find in the subsurface and really hard to remediate," said Thomas F. Zondlo, senior hydrogeologist with Shaw Environmental. "The groundwater plume concentrations that form when water passes over the DNAPLs are easier to locate. But unless you get rid of the source material, the DNAPL itself, you're never going to walk away. It's going to be a very expensive, long-term proposition. What you want to do is remediate the DNAPLs, and what we have found from this investigation is that it's probably going to be impossible to locate all of the DNAPLs, which means it's going to be pretty much technically impossible to remediate some portions of the site. That's called TI, technical impracticability."

The data indicate that any karst cavity, open fracture, or joint in a rock could be migrating or storing DNAPLs. In fact, investigators found more sources in areas where they thought they had located all of the DNAPLs.

And there were more surprises.

"Normally, you'd think that DNAPLs would move straight down under gravity because they're heavier than water," said Zondlo. "But we found that the DNAPLs moved long distances laterally from the site. They went down and hit some rock units or features that were horizontally oriented and stair-stepped off 1500 to 1800 feet from the source areas following the slope or surface that it hit. That was a real finding."

"Based on what we found out here, we will be able to demonstrate to the regulators— EPA and the Alabama Department of Environmental Management (ADEM) — that although we can remediate some places, it's impracticable to ➤

KARST "TOOLBOX"

Although the tools that were used in this study are becoming common place, at the time they were applied in the project, they were novel and really opened up a world of information to the project, according to Thomas F. Zondlo, senior hydrogeologist with Shaw Environmental.

Some tools and results:

FLUORESCENCE SCANNING. Did not prove useful in detecting DNAPLs; delay required in screening rock cores; did confirm petroleum hydrocarbons (naturally occuring). Minimal cost.

REACTIVE RIBBON LINER SURVEYS. Useful in detecting DNAPLs above the water table but success in detecting DNAPLs in the bedrock was inconclusive— primarily for logistical reasons, not because of the technology.

BOREHOLE IMAGE PROCESSING SYSTEM (BIPS). Proved useful in identifying fractures and voids that should be targeted for further investigation. Optical televiewer used to gather a detailed 3D, 360 degree digital image of the borehole to inventory features controlling flow and transport of contaminants. Cheaper, faster.

HYDROPHYSICAL LOGGING (HPL). Literally indicates where the flow intervals are within a hole and the features controlling the flow. Can be accomplished within a day.

PACKER TESTING. Total of 77 tests conducted to document hydraulic parameters in the deeper bedrock and to collect samples from selected intervals. Was slower and more costly than other methods. Pump limitations.

PACKER SAMPLING. Done at selected intervals; was a valuable tool for determining placement of monitoring wells.

OTHER METHODS EMPLOYED. Thermal infrared (TIR) flyover survey, to determine the location of springs; dye trace studies, to determine the flow paths and transport rates of the groundwater; reflection seismic studies, to determine the bedrock structure; Direct Push Technology (DPT), to identify TCE and Perchlorate source areas; and deep bedrock wells, cored to a depth up to 275 feet for deeper subsurface characterization.

SMS provides blueprint for Sustainable Fort Bragg

by Lynda Pfau

'Sustainable Fort Bragg. The Right Way…The Green Way…All The Way.' The phrase is the official policy for Sustainable Fort Bragg as established by the newly adopted Sustainability Management System (SMS).

" 'The Right Way' is obeying environmental laws," said Fort Bragg SMS Representative Dave Heins, chief, Environmental Sustainability Division. " 'The Green Way' is practicing pollution prevention, and 'All The Way' is continual improvement."

Heins explains the purpose and strategic importance of the SMS by comparing it to the basic principles of management utilized by Army leaders at all levels: Plan-Do-Check-Act-Continual Improvement. An SMS provides a structure for leaders to evaluate their activities and determine those actions that have a significant impact on the environment in the same way they conduct a military operation. By applying this structure to the Sustainability Program, we have fully integrated the management process into all major processes on the installation.

"Building a sustainable installation where today's activities and procedures will not eliminate or jeopardize the ability of the installation to meet the mission in the future is our ultimate goal," said Heins. "Our goal is to have an installation capable of supporting the training of soldiers well into the next century. Sustainability is not just an environmental program, it is everyone's responsibility to regularly evaluate their impact on the environment, and the SMS formalizes the process."

The Strategic Sustainability Plan (SSP) provides the means by which a sustainable installation can be achieved. Integrated into the Installation Strategic Planning document, the SSP outlines the goals needed to achieve sustainability as well as the means and measure to achieve those goals. The SMS allows all activities to follow an established standard for evaluating their processes with a goal of recovering our valuable resources.

"Fort Bragg leads the Army in protecting, sustaining, and enhancing the environment so our soldiers and units can do real-world training to support the mission," said Col. Al Aycock, Garrison Commander, Fort Bragg. "To protect our ability to train, everyone working, living or training on Fort Bragg needs to prevent pollution, conserve natural and cultural resources, and protect the environment on a daily basis."

Sustainable Fort Bragg, established in 2001, set much of the groundwork required by the SMS, including establishment of installation goals, setting objectives to attain the goals and building metrics by which to measure achievement levels. As the SMS development process continues, directorates and activities throughout the installation will identify and map core processes that have a significant impact on the environment, whether that impact is positive or negative.

Goal teams developed back in 2001 are reconvening to develop flow charts of processes associated with their specific goal, said Heins.

"This process will help the installation prioritize projects, identify benefits and threats, and inject sustainable practices throughout all levels of activities on Fort Bragg."

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remediate in other cases," said Juana TorresPerez, the district's technical manager for Redstone. "We would also have to convince the regulators that the areas we cannot remediate do not pose a human health risk." Because OU-10 is near the property boundary line, there is the potential for contaminants to migrate offsite into the community.

The district will first submit a written report of their findings to the regulators and then begin the feasibility study, where the different alternatives for remediation will be presented. At that point, the regulators will decide the best treatment for areas that can be remediated.

The district will investigate all 18 operable units at Redstone Arsenal.

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[1] Dense Nonaqueous Phase Liquid— a liquid that is denser than water and does not dissolve or mix easily in water. **PWD**